DOWN TO EARTH

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THE WAR AGAINST SOIL PESTS

IN CALIFORNIA and most west coast agricultural areas wireworms, nematodes, and seed-corn maggots are responsible for tremendous crop losses.

There have been many attempts to chemically control wireworm and other soil pests. Calcium cyanide has been used by application to trap crops, naphthalene has been admixed with the soil, carbon bisulphide and chloropicrin have been applied by spot or interval injection, and beta, beta, dichloroethylether has been used by application of water dispersions to bait rows around growing plants and by irrigation. Most methods used experimentally have had definite limitations because of damage to the land or crops or because of impractical application costs to effect satisfactory control.

Infestation in recent years reached the point where soil pests became a prohibiting factor in raising many truck and field crops. The *California Cultivator*[1] reported in the February 2, 1946, issue, "In some areas these pests caused such a crop loss that growers have ceased producing various vegetables because they could not obtain a yield large enough to break even. . . . However, the new soil fumigants, namely DD and Dowfume (W-10) appear to be the answer to the problem. Nearly a 100 percent control of both bugs (Wireworm and nematode) is obtained and treatment may be effective for about two years."

[1] Crosby, J., 1946. New Fumigants Kill Soil Pests. California Cultivator 93 (3): 65, 92.

Ethylene Dibromide Works

Dowfume W-10 is the result of more than three years research by Dow's Agricultural Chemical Laboratory. The product has undergone extensive testing for the control of wireworms, nematodes, and seed-corn maggots in a variety of representative agricultural areas in Washington, Idaho, Oregon, Utah, and California. Close cooperation by the State, Federal and County agencies was most helpful in the experiments conducted.

Dowfume W-10, which contains Ethylene Dibromide, is a non-corrosive, volatile, water-clear solution possessing a pleasant odor. The product is exceptionally efficient for large scale injection into the soil for the control of various soil pests. Use of the chemical has made it possible to reduce the amount of seed used in planting by 25%—and in some instances as much as 50%. As a matter of fact, results of ethylene dibromide fumigation have been so successful that reduction in planting rate has often been a *necessity* to pre-

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IN THIS ISSUE • *War Against the Wireworm* • *2,4-D Holds Spotlight at Weed Control Conference* • *Methyl Bromide in the Dairy Industry* • *Magnesium in the Apple Orchard.*

ON THE COVER • *This machine, designed primarily for greenhouse soil fumigation, was used in research work conducted in Midland, Michigan, during the 1945 season.*

vent crowding—for plants grown in treated soil show an extraordinary vigor in a high percentage of the experiments.

Remarkable effects have been observed in final yields from treated land. It is not uncommon to obtain an increase in yield as high as 100% of many crops, and in some instances such increases have been as high as 500%.

The Pests

Wireworms

Wireworms are not actually worms, but are the larvae of insects, the adult form of which are known as click-beetles. The female click-beetle (*Limonius Californicus, Mann.*) lays her eggs (150 to 200) in the early spring before most crops are planted. The average incubation period for these eggs is about 30 days. The control of wireworm infestations by ethylene dibromide makes it possible to raise the succeeding season's crop on land virtually free of these insects; while additional eggs may be deposited the following spring, these crops will suffer only minor damage since only young wireworm larvae will be present. Even third-season crops on treated land will be attacked to a much lesser extent than those grown in comparable untreated soil.

The young larvae do not cause appreciable amount of economic damage to the plants for a considerable number of months after hatching. However, wireworms remain in the soil for a period of about three or four years before changing to the adult beetle. It is these older larvae that are responsible for the tremendous damage caused by this pest.

Nematodes

Root-knot nematodes, also commonly known as eelworms or garden nematodes, are among the most serious of the common pests which reduce the yield of field crops. One

Orange County bean field severely damaged by wireworms. July, 1945.

reason for this widespread damage is the fact that their presence is not recognized and their effect is attributed to other pests or soil and climatic conditions. Evidence of their activities is best characterized by stunted, off-color, early wilting plants. The surest indication of root-knot nematode infestation is the presence of bead-like galls on the roots of plants. The energy of the host plant is often expended in producing new roots which are attacked as rapidly as they are formed.

Nematodes are minute worms, so small they are not ordinarily visible to the unaided eye. The adult female nematode is similar to a tiny pearl in appearance and may often be seen when the galls produced on the roots are broken open. The fact that a single female nematode may lay as many as

Action photo of soil fumigant applicator. August, 1945.

Experimental plots at Todd Ranch, Ventura County, California; in the four treated plots, from left to right, Dowfume W-10 was applied at 30, 40, 30, and 40 gallons per acre.

A comparison between wireworm damaged lima bean plants (left) and healthy plants (right) of equal age.

3000 eggs illustrates the extreme importance of keeping this pest under control.

In certain areas of the western United States it is impossible to produce many truck and field crops without the use of a successful soil fumigant.

Seed-Corn Maggots

Seed-corn maggots are the larvae of small flies. These maggots attack germinating seeds and are most commonly found in plantings of corn, beans and peas. Seedlings grown in soil in which eggs of this insect have been deposited, are attacked by young maggots which burrow through the cotyledons and the growing points killing the young plants.

The seed-corn maggot has been satisfactorily controlled by planting seed within a week following soil fumigation with ethylene dibromide and before the seed-corn maggot population has had a chance to build up again. The chemical has been found exceptionally valuable in protecting lima bean seed from attack. Beans following ethylene dibromide treatment often gave better growth than could be explained by the wireworm control attained.

The Experiments

In the 1945 experiments about nine tons of ethylene dibromide were used in 60 different projects which involved about 350 acres of infested land farmed to different vegetable crops. Each experiment was designed in accordance with the problems presented by each field. Some fields were selected because they were so heavily infested with wireworms that the initial stand of lima beans was devastated. These fields were "knocked down", the plots were treated, and the land was replanted to lima beans. Fields were mapped and the degrees of infestation was recorded on the basis of crop damage.

Plot width varied according to location; they were so designed that a seven-shank fumigant applicator could be employed. The length of plots varied from 200 to 500 feet. Whenever possible, replication in a randomized design was practiced.

Because of the manner in which wireworms are distributed within a field, large plots with adequate methods of evaluation are considered imperative. For determining small differences between treatments a refined sampling technique and much replication are required.

The most valid method of plot evaluation is that in which the plants are uprooted and the underground parts examined for wireworm damage. This technique can be used rather late in the season after the wireworms have had a longer period in which to become attracted to the plants and cause damage. (See photograph, left.)

In the determination of the control, one plant was examined every four feet in alternate bean rows of each plot. By this technique hundreds of plants distributed throughout the plot could be examined with a minimum of crop damage.

In evaluating the stand of lima beans in the treatments as compared with the checks, the emerged bean plants in several hundred feet of row per plot were counted and the number of plants per hundred feet of row was calculated.

A method of unbiased sub-sampling was devised in which portions of rows to be counted through each plot were predetermined.

Fields were selected on the basis of worm infestation rather than soil type. The soils were generally silt and sandy loams with a few clay loam types. The degree of organic matter was variable and sometimes varied considerably within the same field. Without exceptions the soils were basic with pH 7.6 to 8.1.

Dosage Required

One gallon of actual ethylene dibromide per acre gave excellent control of wireworm. Greater reductions in worm populations were positively correlated with higher dosages which also controlled the root-knot nematode and other pests.

Generally speaking, satisfactory nematode control was obtained in lima bean fields with a 2 gallon dosage (20 gallons of Dowfume W-10). This dosage is suggested since nematodes and wireworms frequently infest the same field. The chemical is applied in a petroleum extender which serves as a mechanical aid for the application of the chemical to the soil. Ethylene dibromide in an extender is available under the trade name Dowfume W-10.

Application

For use on large acreages, ethylene dibromide should be applied with equipment especially constructed for the purpose. Growers in many west coast agricultural areas will find firms offering soil fumigation services. These firms are prepared to supply the chemical and apply it correctly with proper equipment.

To obtain maximum results, fields to be fumigated with ethylene dibromide should be properly worked and in condition for planting. This means the soil should contain sufficient moisture to insure germination and growth and should be packed and leveled. Land containing even a moderate amount of trash is difficult to fumigate properly since it accumulates on the injector blades and creates wide furrows which are difficult to close with packing devices. Furthermore, trash remaining undecayed in the soil may contain wireworms and nematodes which may not be reached by the fumigant.

An interval of 4 to 7 days without disturbing the soil should elapse between treating and planting to allow the fumigant to exert its maximum effect.

It is interesting to note that effective wireworm control has been attained under a wide range of weather, temperature and soil conditions.

In fumigating for nematode control, a sufficient period should elapse between plowing under the refuse of one crop and treating the ground for a second crop to allow the roots and other trash to disintegrate. The efficiency of the fumigant is increased, if, before treatment, the nematode infested roots are allowed to decompose and release any eggs or young nematodes that may be present in the plant tissue.

Care should be exercised to prevent reinfestation of treated soil by introducing nematodes into the treated area by the use of dirty tools, infested fertilizers or in irrigation water that may be carrying these pests from adjacent infested land.

Most of the experimental plots were treated at a 6 inch depth and the results were very satisfactory. The applicator used is illustrated on page 3.

Experimental plots at Todd Ranch. On each side the diagonal check strip ethylene dibromide was applied at the rate of 1.5 gallons per acre as a 5% solution in standard thinner number 200. In the background to the left is shown a bean field severely damaged by wireworms.

Precautions

Dowfume W-10 is an inflammable mixture, and precautions should be taken to keep fires and sparks from igniting vapors. Prolonged or repeated breathing of vapors should be avoided. Spilling on the bare hands is not dangerous if the liquid is promptly removed, but prolonged and repeated contact with the skin should be avoided. If this material is spilled on clothing or shoes, these articles should be removed until the fumigant has evaporated. Failure to remove shoes on which the chemical has been spilled may cause serious skin blistering.

Conclusions

The loss caused by wireworms, nematodes, and other soil pests is of outstanding economic importance in many sections of the country and especially in the irrigated farming regions of western United States where these tests were conducted.

Satisfactory control is accomplished through the use of ethylene dibromide. An application of 2 gallons of this chemical per acre (20 gallons of Dowfume W-10) usually gives adequate control for both wireworms and nematodes. In severe nematode infestation of land where deep rooted crops are grown, at least 30 gallons per acre may be needed.

Yield of some crops has been increased as much as 500 percent. There has been no indication of crop injury by the use of the chemical. Yield of many crops has been increased in nearly all soil types.

The ingredients of Dowfume W-10 are completely volatile, and there are no harmful residues remaining in the soil to injure germinating seeds or transplants.

2,4-D HOLDS SPOTLIGHT AT WEED CONTROL CONFERENCE

THE RESULTS of 1945 experiments with 2,4-D (2,4 dichlorophenoxyacetic acid) on controlling noxious weeds was the chief topic of discussion at the Second Annual Meeting of the North Central States Weed Control Conference held in St. Paul, Minn. last November. Reports on the effectiveness of 2,4-D sprays and dusts in killing many annual and perennial weeds indicated that this chemical is indeed a very promising weed-killing agent. The uniform plan of experimentation which was designed largely for the 2,4-D trials was followed at least in part by most of the Experiment Stations in 13 North Central States and some of the Canadian provinces. This resulted in data which could be correlated and used much more successfully than if each individual experimenter followed his own particular scheme of plot design and testing.

According to a majority of those reporting upon experimental work at the meetings 2,4-D treatments gave generally good control of the common lawn weeds such as broad leaf plantain, buckhorn, ground ivy, chickory and dandelion. The Conference went on record as favoring the treatment of lawns and other turf areas with 2,4-D. Control of certain deep-rooted perennial weeds was not as clear cut as that of many annuals. However, field bindweed, Canada thistle, sow thistle and leafy spurge, which are prominent in the group of the more serious weed pests of the North Central States, are among those for which the control of 2,4-D holds much promise. Hoary cress (white top), horse nettle and Russian Knapweed seemed to be more difficult to control with this herbicide. Yet they do respond and it is quite possible that with proper concentration and timing of applications, 2,4-D may prove effective in eradication programs. Among the noxious woody plants, poison ivy gave somewhat variable results but a good kill resulted from enough tests to warrant further testing to determine the growth conditions most susceptible to 2,4-D, the most opportune season of application and the most effective formulation of this chemical for this particular plant. Many other woody plants were reported to be seriously affected by 2,4-D, but the actual amount of kill and degree of control can not be determined until spring when the relative amounts of recovery and regrowth can be measured.

Conferees were in general agreement on the premise that 2,4-D should be applied when plants are in an active growing condition. On mowed or pastured turf, sprays may be applied over a long season since under such conditions

These weeds (Common mullein) were sprayed with 2,4-D at the rate of 1000 ppm. Pictures taken at the date of spraying and at five later dates show the results.

plants are kept actively growing so long as sufficient moisture is available. Elsewhere, applications are usually more successful if made after growth is well underway but before the unwanted plants begin to flower and form seed. The exact time of the year will vary with species and geographic location. Many experimenters noted that more rapid and often more complete kill was obtained when warm weather followed applications.

Perhaps the most interesting sessions of the conference were lively discussions, centered around the topic of how 2,4-D kills plants. Further research on the physiology of plants treated with this and other growth-regulating substances is needed but a few facts and several theories have already been advanced. Some of the comments made at the meeting by various investigators are of considerable interest.

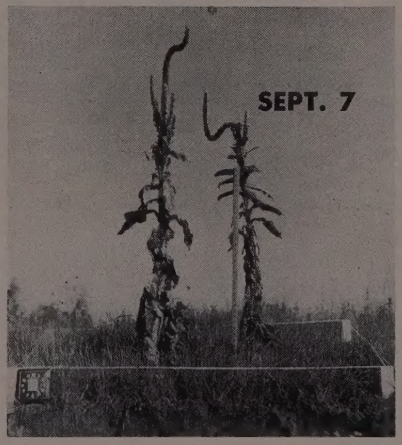
1. 2,4-D application to foliage often results in a marked decrease of starch and an increase of sugar in various plant parts. Apparently starch hydrolysis is an important factor in the break down of treated plants.
2. Respiration is speeded up materially following 2,4-D treatment.
3. Much of the translocation of 2,4-D, or its effect, is apparently downward; however, it also moves upward and laterally as well.
4. Growth-regulating substances produce more pronounced effects in direct sunlight. This has been proven experimentally and it is a common observation that 2,4-D often gives less satisfactory control of noxious weed plants in the shade. Possibly this difference is related to the carbohydrate content of plants at the time of treatment.
5. Hereditary differences between plants within a species in their response to 2,4-D have been found to exist. This may account for some of the variable results observed on certain common weeds such as chickweed.

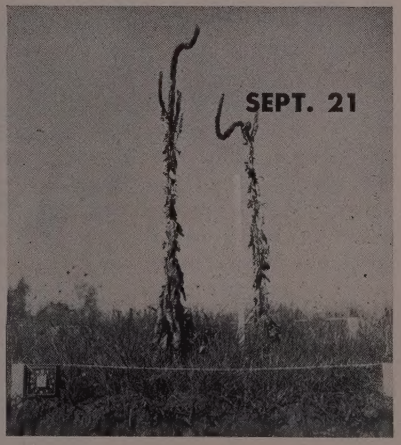
Bindweed, unsprayed.

Bindweed, 7 days after spraying with 2,4-dichlorphenoxyacetic acid at the rate of 1,000 ppm. The plant appears very abnormal at this stage. It is dying—slowly but surely.

Reports made at the conference indicate that though 2,4-D is toxic to animals when eaten in relatively large amounts, this chemical as utilized via the usual weed-killing formulations is relatively non-toxic. In one test for instance, sheep and cows which grazed on pasture treated with twice the amount of 2,4-D that would ordinarily be used apparently were not affected in any way.

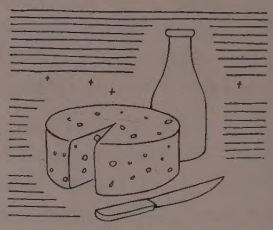
Even though all the answers are not known, wide use of 2,4-D in weed-killing formulations to control a great variety of noxious weed plants is indicated for 1946.





Use of METHYL BROMIDE

IN THE DAIRY INDUSTRY



Animal pests in the past have destroyed and contaminated dairy products involving considerable economic loss. These pests are now being controlled with Methyl Bromide in dairy factories throughout the dairy industry.

FOR MANY YEARS Methyl Bromide has been used successfully as a fumigant to control animal pests of the dairy industry. The most troublesome of dairy pests include cheese mites, cheese skippers, flies, roaches, rats and mice. Because of its toxicity to all forms of insect life including the eggs, and because of its effectiveness at low or high temperatures, one proper application of Methyl Bromide is sufficient to control these pests in vaults, coolers, curing rooms, factories or warehouses. It is not necessary to move or lift stock or to open boxes in order that the pests be reached. Careful analysis of fumigated dairy products by Dow Research Workers[1] has revealed no injurious residues, off-tastes, odors, or harmful effects to the plant or equipment in which Methyl Bromide has been used. In fact, bacterial cheese starter left in cheese factories during fumigation is not affected. Methyl Bromide also has the advantages of relative insolubility in water, ease of application, and rapid aeration. Moreover, it is noninflammable and nonexplosive.

The research work to determine the efficiency of Methyl Bromide as a dairy plant fumigant was undertaken as a cooperative project between the University of Wisconsin, The National Cheese Institute, and The Dow Chemical Company.[2]

Dairy plants in general have ideal conditions for supporting insects and rodents; namely, high temperatures and humidity and an abundance of food. This problem is of tremendous importance to the dairy industry because of the destructive feeding and contaminating habits of these pests.

Methyl Bromide is a liquified gas with a boiling point of 40.1°F. Under atmospheric conditions, it is a colorless, tasteless, and practically odorless gas. It is packaged in 10, 50, 100, and 175-pound cylinders and one-pound cans. When the containers are opened, the liquid Methyl Bromide is forced out by its own vapor pressure plus additional air pressure included at the time of manufacture. It immediately turns to a gas and diffuses into the atmosphere. Being over three times as heavy as air, it tends to settle in a tight room, thereby, necessitating the use of a fan or a blower for rapid distribution throughout the space. When it is distributed thoroughly throughout a room in killing concentrations, the gas possesses no warning properties. However, a special apparatus known as a halide leak detector is used for detecting the presence of this gas.

A successful fumigation may be carried out in any plant by adhering strictly to the following procedure:

1. *Calculate the number of cubic feet of space in the rooms or the structure to be fumigated.* Obviously, this is very important if successful results are to be obtained. The number, size, and positions of Methyl Bromide cylinders or amount of gas used depends largely upon the size of the rooms.

2. *Seal all cracks, holes, ventilators, flues, doors, windows, and intakes.* The usual penetrating properties of Methyl Bromide become limited if the dairy plants are not tight enough to hold the gas. Many things can be used for sealing such as masking tape, waterproof tar or asphalt building paper, greased or oiled Kraft paper, putty, caulking compound, or a mixture of 8 parts asbestos, 3 parts calcium chloride, and 4 parts water by weight.

3. *Introduce and distribute Methyl Bromide.* Under reasonably favorable conditions experiments have indicated that all pests in the average dairy plant may be controlled by using 1½-pounds Methyl Bromide per 1000 cubic feet of space for eight hours at temperatures of 70°F. or above. In cold storage warehouses where temperatures are considerably lower, one-pound of Methyl Bromide per 1000 cubic feet of space for 24 hours will control mites and rodents.

Methyl Bromide may be released directly from cans or cylinders depending upon the size of the building or rooms to be fumigated. The gas from cylinders is usually sprayed directly into the building space by simply opening the valves. A fumigant piping system such as is commonly employed in flour mills may be successfully used in fumigating dairy plants.[3]

[1] L. S. Roehm, V. A. Stenger, and S. A. Shrader, *"The Fumigation of Dairy Products with Methyl Bromide"*, Journal of Dairy Science, Vol. 24, 1943.

[2] E. M. Searls, F. W. Fletcher, and E. E. Kenaga, *"Methyl Bromide as a Fumigant for Dairy Factories"*, Journal of Economic Entomology, Vol. 37, 1945.

[3] For complete information send for Dow Booklet: *Methyl Bromide Applicators and Supplementary Equipment;* The Dow Chemical Company; Midland, Michigan.

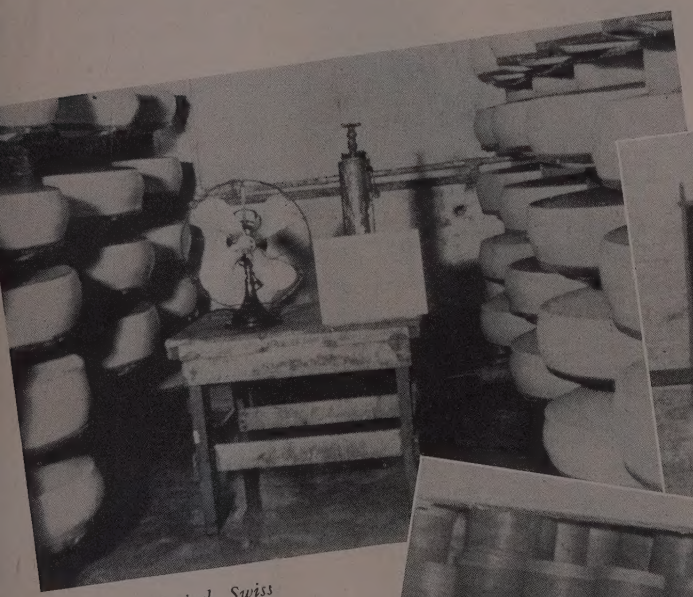
For the distribution of the gas, an ordinary house fan, one for each 10,000 cubic feet of space, will provide sufficient air circulation. If a circulation fan or unit heater is already present, fewer fans or a shorter circulation period is required. Normally, thirty minutes to one hour provides sufficient circulation.

4. *Take all necessary precautions.* Methyl Bromide is toxic to man as well as animals; therefore, in all fumigation work precautions must be taken to protect property and people associated with the fumigation. Certain items such as sponge rubber, rubber aprons or boots, white kid leather, iodized salt, and furs must be removed as they produce a disagreeable odor when in contact with Methyl Bromide vapors. All animals and house plants should be removed. And all flames, such as furnace fires, gas jets, etc., must be extinguished previous to fumigation. Moreover, all doors, windows, and other large openings should be barricaded or locked to prevent accidental entry by any person during fumigation period. Poison signs should be placed conspicuously on all doors immediately upon release of the gas to warn against entry by anyone. Local laws and regulations pertaining to fumigation should be checked and the police and fire departments notified as to the time of the fumigation.

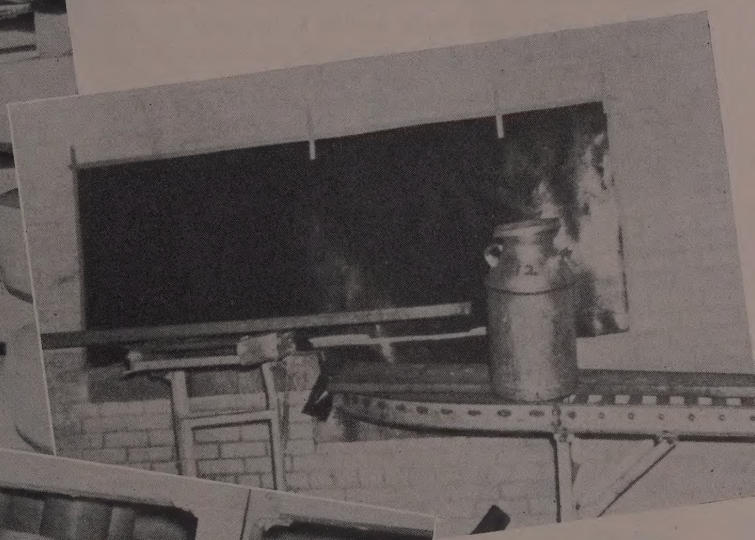
At least two men should work together on a fumigation job, both wearing proper masks and canisters at all times when exposed to Methyl Bromide vapors.

5. *Aerate the building before reoccupation.* When the fumigation period has terminated, two people with proper gas masks should enter the building and open all doors, windows, and other large openings to insure cross-ventilation. The fans or heater units may also be turned on to assist in aeration. The building must be aerated from one to two hours depending upon the wind velocity. Under no conditions should the building be reoccupied until a halide leak detector shows complete absence of all gas.

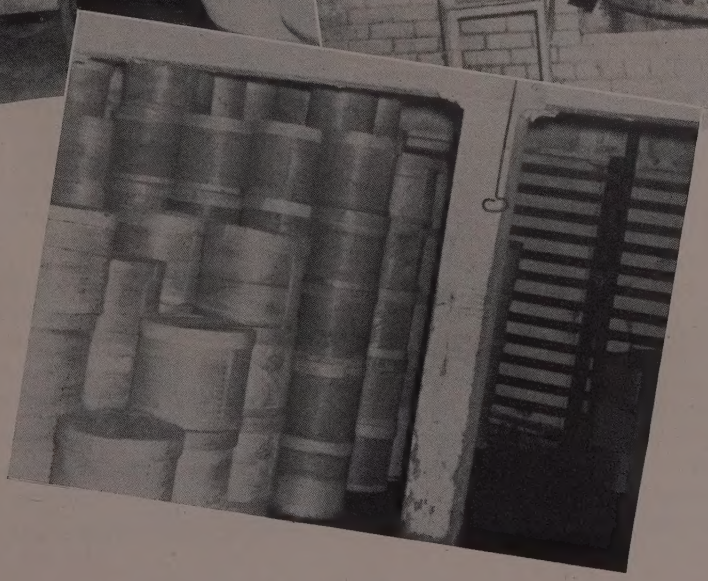
Thus, when the recommended sealing, application, and circulating methods are used, Methyl Bromide will give satisfactory control of all dairy pests. Methyl Bromide will not injure the dairy products or equipment within the plant and although poisonous to man and animals it can be handled with safety.



Above: Typical Swiss cheese curing room.



Above: Intake completely sealed with gas-proof asphalt paper and wet paper.



Right: Cold storage room in an American cheese factory.

MAGNESIUM in the APPLE ORCHARD

MAGNESIUM is one of the mineral elements essential to normal plant nutrition. As early as 1840, Liebig considered magnesium to be an essential element since it was found in considerable amounts in plant ash. Willstatter in 1906 first showed that magnesium is one of the constituents of chlorophyll and now it is recognized to be the key element in this substance which is so essential to green plants. With the aid of chlorophyll, the energy from the sun is utilized to build up plant tissue which, directly or indirectly has supplied man with most of the necessities and luxuries of life.

Green chlorophyll contains 2.7 per cent of magnesium in its chemical makeup. However, since only about 10 per cent of the magnesium required for normal plant growth is contained in the chlorophyll, this element probably has other essential functions. Along with nitrogen, potassium, phosphorous, calcium, and sulfur, magnesium is a major nutrient element and is utilized in considerable quantity by orchard trees as well as other crop plants. When the supply of this element is insufficient, deficiency in crop plants such as tobacco, corn, potatoes and some vegetables has been a problem for a number of years in Atlantic coastal areas. In Florida magnesium requirements of citrus trees have not been satisfied by native soil supplies and fertilization with magnesium compounds has become quite prevalent. Recently it was found that tung trees responded markedly to magnesium applications.

Symtoms of magnesium deficiency on apple trees have been recognized only very recently in this country (1) (5) although the trouble has been known in England, Canada, and New Zealand for several years. It is true that the symtoms have been observed for a number of years but the cause was usually identified as drought injury, spray burn, etc. Typical magnesium deficiency symptoms usually appear in late summer. In late July or August apparently normal trees develop a leaf scorch which characteristically appears as irregular areas on the leaf blades. This necrosis is often preceded by a fading out of the green color and with some varieties there is considerable leaf mottling and coloration. The first leaves to show deficiency scorch are usually the older ones near the bases of the current year's shoot growths and the scorch may progress upward as the season advances. Affected leaves often drop early, leaving bare stretches of wood. In serious cases most of the foilage may be affected and pre-harvest drop of fruit is hastened. Furthermore, apple quality is inferior and tree growth is reduced. Seriously deficient trees are not productive nor profitable. The extent and severity of magnesium deficiency in eastern apple orchards seems to be increasing. Hence, effective control measures are eagerly sought by growers.

Several approaches to the problem have proven more or less successful. Adequate soil applications of magnesium oxide and magnesium salts (such as Epsom salts) have given generally good results on young trees, but a much more delayed response has been characteristic of older trees (6) (7). The results as given in the Table 1 taken from the recent report by Southwick and Smith (7) are typical. (Please see back cover for tables.)

In many tests high magnesium or dolomitic limestone applications have been relatively ineffective unless the lime was thoroughly dug into the soil around the roots as was done by Boynton in New York. The data in Table 2 are from a table printed in a recent report(3).

The inclusion of Epsom salts in two or three post-blossom spray applications has been effective (1) (3) (4) (6) (7) as was also the use of high magnesium spray lime in the cover sprays (3). The data in Tables 3 and 4 are condensed from two tables in recent reports by Boynton (3) and Southwick (7).

Investigators have also shown that magnesium deficiency may be worse under conditions of high potassium nutrition (2) (4) (5). Boynton recently reported that magnesium deficiency leaf blotch was induced in McIntosh apple trees following fertilization for 3 or more years with potash (2).

It is interesting to note the decided trend toward leaf analysis as a method to determine the effectiveness of soil or foilage fertilizer treatments. This approach seems to be extremely important in aiding plant scientists to evaluate

results promptly and accurately. It has helped greatly in recent magnesium deficiency studies on apple trees.

There are several problems still being assiduously studied by research workers. Nevertheless, it can be said that this recently recognized agricultural problem is being successfully solved.

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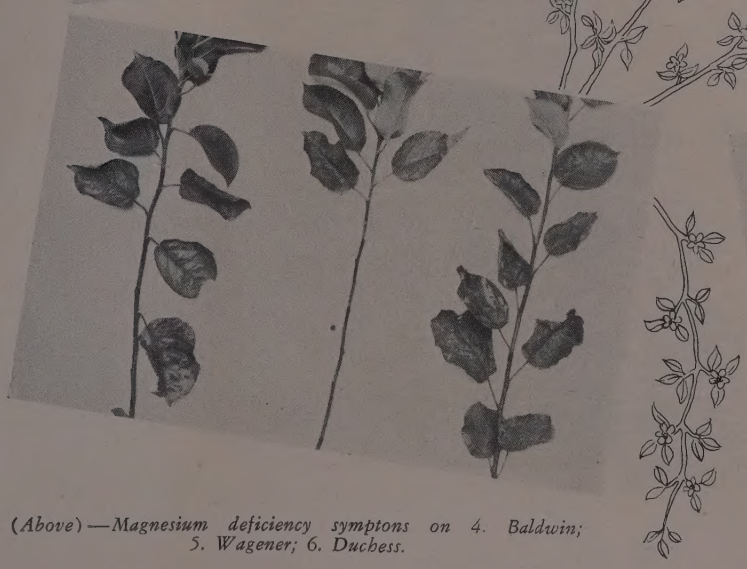
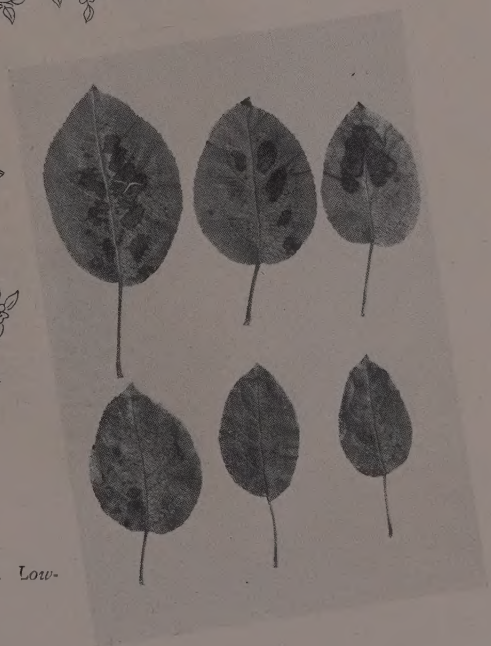
[7] Lawrence Southwick and C. Tyson Smith. Further data on correcting magnesium deficiency in apple orchards. Proc. Amer. Soc. Hort. Sci. 46: 6-12 . . . 1945.

Magnesium deficiency symptoms on shoots. 1. G. Delicious; 2. Gravenstein; 3. McIntosh.



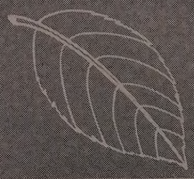
(Above)—Magnesium deficiency symptons on 4. Baldwin; 5. Wagener; 6. Duchess.



(Right)—Upper: Magnesium deficiency on McIntosh leaves. Lower: Potassium deficiency on McIntosh leaves.

TABLE 1

TREATMENTS, MAGNESIUM DEFICIENCY LEAF SCORCH, AND LEAF ANALYSIS • ORCHARD B-2, MASSACHUSETTS STATE COLLEGE

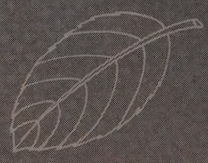


Plot	No. of Trees	Treatment Sep. 1942 (Soil Applications per tree)**	Approx. Trees with more than a trace of scorch (Per Cent)					Leaf Anal. (Sep. 1944)* % of Dry Wt.			% of Ash as MgO
			Sep. 1941	Aug. 1942	Sep. 1942	Sep. 1943	Sep. 1944	Mg	K	Ca	
2	20	5 lbs. Magnesium Oxide	65	63	92	2	5	0.39	1.83	0.98	10.74
7	20	5 lbs. Magnesium Oxide						0.38	1.61	1.27	9.69
3	20	5 lbs. Epsom salts	55	58	90	2	3	0.29	1.91	1.21	7.59
6	20	5 lbs. Epsom salts						0.31	1.97	1.12	8.13
4	20	25 lbs. Dolomite	35	50	82	42	13	0.25	2.11	1.13	6.41
5	20	25 lbs. Dolomite						0.26	1.94	1.47	6.24
1	20	Check	35	38	85	22	18	0.23	1.79	1.40	5.92
8	20	Check						0.24	1.95	1.24	5.82

*Six leaves per tree in each sample.
**Commercial Dolomite (Magnesium Limestone)—20 per cent MgO.
Epsom Salts ($MgSO_4 \cdot 7H_2O$)—16.3 per cent MgO.
Magnesium Oxide—92 per cent MgO.

TABLE 2

SOIL ACIDITY AND ESTIMATED CALCIUM AND MAGNESIUM CONTENTS IN SOILS UNDER LIMED AND UNLIMED TREES AFTER TWO YEARS OF LIMING



Trees	Treatment	2-6 Inch Depth*			8-12 Inch Depth*		
		pH**	Ca Pounds	Mg Per Acre	pH	Ca Pounds	Mg Per Acre
1-10L	Lime	6.26	1,950	398	5.23	530	111
1-10C	CK	4.63	120	10	4.68	130	10
11-20L	Lime + Epsom Salts	6.38	3,275	315	5.61	545	101
11-20C	CK	4.60	105	10	4.73	90	11
		DeRight Orchard, Wayne County (Dunkirk Fine Sandy Loam)					

*Each figure is the mean of 10 determinations. All differences are highly significant statistically. **The mean pH was calculated by averaging H ion concentrations and converting back to pH.

TABLE 3

ANALYSIS OF LEAVES FROM BALDWIN TREES IN RELATION TO MAGNESIUM SPRAYS APPLIED IN 1944 (BOYNTON)

Treatment	Leaf Magnesium (Per Cent Dry Weight)
Check	0.11±0.013
1 separate spray of 1 per cent Epsom salts	0.24±0.024
1 separate spray of 2 per cent Epsom salts	0.24±0.038
2 separate sprays of 2 per cent Epsom salts	0.23±0.025
2 per cent mg. spray lime in cover sprays	0.28±0.025

Mg Spray Treatment (No. and Year of Applications)	Trees Showing Medium to Severe Scorch Aug., 1942 (Per Cent)	Trees Showing Various Amounts of Leaf Scorch, Sep. 1944 (Per Cent)				Total No. Trees (Sep. 1944)	Leaf Anal. Aug. 1944 Per Cent of Dry Weight		
		O-Trace	Light	Medium	Severe		Mg	K	Ca
			Section 1						
4 in 1943) 3 in 1944)	62	99	1	0	0	139	0.26	2.17	1.17
			Section 111						
Check	45	54	29	12	5	136	0.19	2.19	1.26

TABLE 4

TREATMENT, MAGNESIUM DEFICIENCY LEAF SCORCH, AND LEAF ANALYSIS • ORCHARD B-1, MASSACHUSETTS STATE COLLEGE (SOUTHWICK AND SMITH)